students such as attend the Royal College of Chemistry and other science schools, but rather for those who take up chemistry either as a branch of general education or as an evening study, and for this purpose it seems to be well fitted; at the same time there is the danger of cram to be guarded against. The author evidently feels this and has endeavoured to provide against it in a somewhat original manner. Pages 102–121 are divided into double columns, the left hand one on each page containing the preparation or reaction formulæ of one of the non-metallic elements and their more simple compounds; the right hand column is left blank, and the student is requested to note the conditions under which each substance is prepared either from the lecture or from a text-book. This device would if conscientiously carried out by the teacher, probably prevent cram of a certain sort, and compel the student to know a little more than the mere formula of a reaction or preparation. At the same time we must confess that we must still regard this knowledge as only another form of cram which is infinite in its varieties and made to suit the idiosyncrasies of each individual examiner, and which will exist as long as any form of knowledge continues to be looked on as something to "pass" an examination in; and as long as examiners continue to look only to a set of answers given on a certain day in a certain time to a particular set of questions, and not to the general character and capacity of the student. We therefore think that Mr. Eltoft will meet with failure in his well-meant effort; we trust, however, that he will continue to persevere.

The rest of the book is divided into double pages, meant for notes on particular elements, the pages being divided according to a scheme in which specific gravity, in the state of solid, liquid, or gas, colour, melting-point, and boiling-point, are successively considered. Another space is reserved for the description of the experiment, a third for sketches of apparatus, and a fourth for tests for the identification of the body. These pages will no doubt teach the student to systematise his notes to a very considerable extent and indicate to him a detailed method of observation.

In conclusion, we note that Mr. Eltoft, in his short preface, expressly states that his "note-book" is "not in any way supposed to take the place of a text-book, but to act as an adjunct to it." We regard it in this light as an honest effort to assist the large class of students for whom it is intended, and we hope that the author will watch the effect of the book on the classes he is teaching, look on his present effort as experimental, and come forward again with the aid of his increased experience to still further improve his work.

R. J. FRISWELL

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Solar Physics at the Present Time

IN reference to Prof. C. P. Smyth's letter in NATURE, vol. xv. p. 157, I think it my duty to state that Prof. Smyth's remark on the priority of his exhibited results of observations of deep-sunk thermometers (as bearing on the question of transmission of waves of temperature into or from the interior of the earth) is perfectly correct.

It was only in the last summer that, having occasion to inspect some parts of Prof. Smyth's printed "Observations," I became acquainted with the extensive series of diagrams illustrating this matter. I have not yet been able to refer to his cited paper in the "Philosophical Transactions." G. B. AIRY

Royal Observatory, Greenwich, S.E.,
1877, January 1

Just Intonation, &c.

UNDER this heading your correspondent "A. R. C.," while explaining Mr. Colin Brown's "natural finger-board," writes thus:—"The vibration numbers of the diatonic scale being represented by—

$$1,\ \frac{9}{8},\ \frac{5}{4},\ \frac{4}{3},\ \frac{3}{2},\ \frac{5}{3},\ \frac{15}{8},\ 2.$$

If we build upon the dominant $\frac{3}{2}$, the vibration numbers will be—

$$1,\ \frac{9}{8},\ \frac{5}{4},\ \frac{45}{32},\ \frac{3}{2},\ \frac{27}{16},\ \frac{15}{8},\ 2,$$

and if we build upon the subdominant $\frac{4}{3}$ the vibration numbers will be—

$$1,\ \frac{10}{9},\ \frac{5}{4},\ \frac{4}{3},\ \frac{3}{2},\ \frac{5}{3},\ \frac{16}{9},\ 2.$$"

Unless "A. R. C." proposes some new system of tuning, I submit that he is in error in the first steps of his two examples. The dominant of C is G, and from G to A is a minor, and not a major, tone. Also the subdominant to C is F, and from F to G is a major, and not a minor, tone. I do not pursue the analysis, not desiring to criticise oversights, but to draw attention to a not uncommon misconception of the figures in the above scale, and to the general adoption of a miscalculation as to the so-called "Comma of Pythagoras."

An eminent mathematician, not long deceased, derived our diatonic scale from the one note F, by the following process:—"F A C—C E G—G B D," thus taking the common chords of three different keys. Had he followed out his system of adding on a new scale from the Fifth of the preceding, he would have gone the round of the keys, and have derived them all from F, which would have been the *reductio ad absurdum*.

Nothing can be clearer than the history of the scale, and it carries with it conviction of its truth. The octave was formed out of two Greek conjoined tetrachords, such as B C D E and E F G A, the E being common to both. Then the lower A was added at the bottom, to complete the octave, and it was called "the added note" (*proslambanomenos*) because it did not form part of any tetrachord. The reduction from the eight notes of the two tetrachords to seven is attributed to a superstition in favour of the number seven. Thus came our A B C D E F G A—a minor scale with a minor Seventh—and from it came our truer major scale, by commencing on the third note, C, but carrying with it all the imperfections of the double root of the original. No improvement has been made in the scale since the days when Archytas, the friend of Plato, introduced the consonant major Third, and Eratosthenes the minor Third. Our present scale is therefore absolutely anterior to the Christian era; the ratios of its intervals given by Greek authors prove the identity irresistibly. Let us then look to the figures which represent our scale as "A. R. C." has justly given them. The large 1 and 2 refer to C as the fundamental note and its octave. The 3 to 2, the 5 to 4, the 9 to 8, and the 15 to 8 represent octaves of the key-note (2, 4, or 8); but the 4 to 3 (the interval of a Fourth) and the 5 to 3 (the interval of a major Sixth) refer to C only as the so-called "Twelfth" above F, and not to C as the octave. If we play either of these two notes, F or A, with C, we cannot use C as a consonant bass. We must take F, and thus we have the old tetrachord system, with its double root, running in our present scale. In all keys the tonic and the subdominant are both necessary basses. F and A belong exclusively to F; but B and D have no relation to F, not being aliquot parts of the F string. They belong to the scale of C, but more intimately to that of G. The F string exceeds the length of the C string by 3 to 2, because its sound is that of a Fifth below C; therefore any attempts to bring the sounds of our scale to a common denominator are fallacious, the first law of Proportion being that "Ratio can subsist only between quantities *of the same kind*." Thus the "24, 27, 30, 32, 36, 40, 45, 48," cannot be accepted, because the 32 intended for the 4 to 3 of the scale, and the 40 for 5 to 3, represent other intervals. The 4 to 3 of C is the Fourth from C down to G, and the 5 to 3 of C is the major Sixth from E down to G. The 32 and 40 are not applicable to the interval of a Fourth from F down to C, nor to the major Sixth from A down to C.

And now as to the so-called "comma of Pythagoras," a strange name for the interval of 531441 to 524288! Can the modest inventor, who has concealed his own name, have supposed that the Greeks had musical instruments so very far

beyond the compass of our seven or eight octave grand pianofortes? This interval is simply the excess of the twelfth power of 3 over the nineteenth power of 2. As powers of 3 are Twelfths, in music—octaves with Fifths, and not merely Fifths—and as octaves are powers of 2, this comma represents B sharp as topping C in its *nineteenth* octave. Happily any nineteenth octave is beyond our powers of hearing, even if we adopt a No. 1 with only one vibration in a second of time. We may therefore dismiss so disagreeable a sound to the so-called "Music of the Spheres," in compliment to Pythagoras, who is supposed to have been acquainted with music of that kind.

We are too generally prone to rely upon the labours of our predecessors, and hence this peculiar comma has been received without examination, as the overlapping of twelve Fifths over seven octaves, as stated by "A. R. C." After having traced what it really is, wishing to find the author of the miscalculation, I took up a newly-acquired copy of Koch's "Musikalisches Lexicon," which, although written in the last century, is still reputed as a work of authority, and has been re-edited by Arrey von Dommer (8vo, Heidelberg, 1865). I found a more curious mistake: instead of twelve Fifths, it is there stated to be twelve Fourths *or* Fifths; and Koch's way of proving it is by multiplying the ratios, not as fractions, but as whole numbers. For example, a Fifth and a Fourth we know to make one octave, but Koch multiplies 3 times 3 = 9 in one column, and 4 times 2 = 8 in the other (p. 24). As the twelve threes are in one column, he arrives by multiplication at the twelfth power of 3, and as the fours and twos are in the other column, he arrives at the nineteenth power of 2. It is desirable that this should be known as a caution against too-ready acquiescence in Koch's calculations.

WM. CHAPPELL

On "Comatula (Antedon) Rosacea," and the Family "Comatulidæ"

MAY I be allowed to point out to Mr. Stebbing that *Comatula* and *Antedon* are not precisely equivalent names, but that the genus *Antedon* represents only one of some five or six different types, to all of which "Lamarck's happily appropriate designation *Comatula*" is equally applicable; and that this is now generally used as a sort of family name, and only when strict scientific accuracy is not very important, as a generic name.

Johannes Müller, who laid the foundation of nearly the whole of our present knowledge of the zoology and morphology of the family, was the first to recognise that Lamarck's designation, *Comatula* included more than one type; in his well-known memoir, "Ueber die Gattung *Comatula*, Lamarck, und ihre Arten," he indicated two distinct varieties of *Comatulæ*, the one represented by the ordinary *Comatula rosacea*, with a central or subcentral mouth, and symmetrically distributed ambulacral furrows; and another, which he first recognised in the ordinary *Comatula solaris*, Lamarck, to which he gave the name *Actinometra*: in this type the mouth is marginal, and the furrows of the ten arms open at equal intervals into a circular furrow running round the edge of the disc, the centre of which is occupied by the anal tube. The first of these types is that to which de Freminville's name of *Antedon* is now usually applied. Müller, however, seems never to have been acquainted with this name, and adopted Leach's genus *Alecto*, which was constituted three years subsequently to *Antedon*; while *Comatula* did not appear till a year later. Recent observations have, however, shown that *Alecto*, as used by Müller, really includes many forms that are true *Actinometræ*, and the name has passed gradually into disuse, in its original application to the Crinoids; this was all the more necessary, as the name has been generally received as designating a genus established by Lamouroux in 1821, for a section of the Polyzoa.

Müller was in the habit of using a sort of trinomial nomenclature in his descriptions of the species of *Comatula*; thus, *Comatula* (*Alecto*) *europæa*, and *Comatula* (*Actinometra*) *solaris*; it will probably be advisable to continue this practice, and it is therefore somewhat unfortunate tha Mr. Norman[1] should have transposed *Antedon* into a masculine name, for de Freminville, who first proposed it, used it as a feminine one, and described his first and only species as *Antedon gorgonia*, which is probably the same as *Comatula carinata*, Lam. Pourtales has already adopted *Antedon* as a feminine name, and we should probably do well to follow his example, especially if we employ Müller's very convenient system of trinomial nomenclature, for it is far simpler to write *Comatula* (*Antedon*) *rosacea*, than *Comatula rosacea* = *Antedon rosaceus*.

Besides these two types *Antedon* and *Actinometra*, there is, as Müller pointed out, another division of the *Comatulæ* represented by the recent *Comaster* of Agassiz and the fossil *Solanocrinus* of the Wurtemburg Jurakalk; these are distinguished from the ordinary *Comatulæ* by the fact that five small basals appear externally between the first radials. The five small ossicles lying between the second radials of *Antedon Dübenii*, Böhlsche, are possibly also external basals. It is unfortunate that Böhlsche was unable to make a further examination of this species, and so determine this very interesting point.

Müller considered *Solanocrinus*, or at any rate *S. costatus* and *S. scrobiculatus* as generically identical with *Comaster*, and pointed out that the differences in the form of the "knopf," or centrodorsal basin, which is elongated and more or less fusiform in *Solanocrinus*, and hemispherical in *Comaster*, could not be regarded as of generic value, for similar differences occur among different species of the recent *Comatulæ*; *e.g.*, between *C. Eschrichtii*, Müll. and *C. phalangium*, Müll. I have recently found that such differences may occur within the limits of the same species. Thus, of the two specimens of *Comatula* (*Antedon*) *macrocnema* in the Paris museum, one has a hemispherical centrodorsal basin, just like that of *Comatula* (*Antedon*) *Eschrichtii*,, while in the other it is a short pentagonal or nearly circular column, on which the cirrhi are disposed in four alternating rows, precisely as in *Solanocrinus*. Götte, who has recently made some most beautiful observations upon the embryology of *Comatula*, opposes the view first suggested by Sir Wyville Thomson, and since adopted and strengthened by Dr. Carpenter, that the centrodorsal basin represents a coalesced series of the nodal or cirrhus-bearing stem-joints in the stalked Crinoids, but its condition in *Solanocrinus* and *Antedon macrocnema* seems to show unmistakably that Sir Wyville Thomson's determination of its homologies is the correct one, especially when it is remembered that, as Goldfuss says, young specimens of *Solanocrinus* are not uncommon, in which the articular surfaces of the segments composing the elongated "knopf" are visible, although in the adult animal they become so closely united as to be inseparable.[1]

Unfortunately we do not know the position of the mouth in *Comaster*, the only specimen yet known having been dissected by Goldfuss, who says little or nothing about the ventral surface; but in *Phanogenia*, a new genus of the free Crinoids established by Lovén, it is central, as in *Antedon*.

These four types, *Antedon*, *Actinometra*, *Comaster*, and *Phanogenia*, all currently regarded as belonging to Lamarck's genus, *Comatula*, differ very considerably from one another in many points, perhaps the most characteristic of which is the condition of the basals in the adult animal.

In *Antedon*, as shown by Dr. Carpenter, the primitive basals of the Pentacrinoid larva undergo a very remarkable metamorphosis into the small and relatively insignificant "rosette;" this is almost entirely inclosed within the circlet of first radials, with which it becomes more or less fused in the adult animal, and by which it is so concealed as very readily to escape notice; so that all the older investigators either denied the existence of basals at all, or like Goldfuss, mistook the first radials for basals. I have recently found that in *Actinometra solaris* (Müller's typical species), and in several other species of the genus, the basals are relatively very large, and take the shape, not of a "rosette," but of a five-pointed star, the rays of which lie on the dorsal aspect of the five sutures of the first radials with one another, while its centre is simply an open and very delicate calcareous network, more or less connected with that proceeding from the inner surface of the radial circlet. These basals are readily exposed by the removal of the flattened centrodorsal basin, the ventral aspect of which exhibits five stellate interradial depressions, into which the basals fit, but they never extend outwards so far as to be visible externally.

This last condition, of external basals, occurs, however, in *Comaster*, and in the Jurassic *Solanocrinus*. The centrodorsal basin of *Comaster* is hemispherical, and round its ventral margin lie five small triangular basals, not in contact with one another, but so widely separated that the first radials lying between them

[1] "On the Genera and Species of British Echinodermata," Ann. Mag., N. H., xvi. 1865.

[1] Further, in the singularly minute *Comatula alticeps* found by Philippi between the valves of a fossil *Isocardia cor* from the Sicilian Tertiaries, the centrodorsal, which he calls the "kelch stück," is elongated, egg-shaped, and visibly composite, bearing at least two, and very probably several more, alternating rows of cirrhi just like that of *Antedon macrocnema*. I have little doubt but that this species was a true *Antedon*, and an ancestor of our recent *Antedon rosacea* which is now so common in the Mediterranean.